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# Uniting Individual and Collective Concerns Through Design: Priming Across the Senses

## Design Studies

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- > An experimental study distilling and implementing a behavioural design intervention.
- > Demonstration of priming through everyday artefacts.
- > Compares interventions targeting different senses: vision, hearing, smell, and touch.
- > Elaborates self-construal as a means for dissolving individual and collective concerns.
- > Key learnings for behaviour change through design are identified.

## Abstract

This paper contributes to design for behaviour change by testing the potential of priming via everyday products as a means of influencing users and dissolving conflicting individual and collective concerns. Self-construal is introduced as a core explanatory concept with respect to behaviours that unite individual and collective concerns. Two studies are reported. In the first, abstract representations of the target behaviour are elicited and incorporated into subconscious priming stimuli for each of the major senses: sight, hearing, touch, and smell. These primes are then evaluated in a controlled experiment. From these studies implications for both researchers and practitioners are identified. In particular, priming showed a significant effect across all senses.

**Keywords:** user behaviour; behavioural design; design method; product development; social innovation

This work contributes to the on-going research on design as a means for promoting positive behaviour change (Bloch, 1995; Cash, Gram Hartlev, & Durazo, 2017); and in particular, uniting individual and

collective concerns to produce products that are both pro-social and pro-user (Tromp & Hekkert, 2016; Tromp, Hekkert, & Verbeek, 2011). In this context, self-construal provides key insight into how conflicting individual and collective concerns might be dissolved (Cross, Hardin, & Gercek-Swing, 2011; Voyer & Franks, 2014). Self-construal describes *“the relationship between the self and others and, especially, the degree to which [people] see themselves as separate from others or as connected with others”* (Markus & Kitayama, 1991, p. 226). However, operationalizing this in behaviour change has been little addressed in prior works on persuasive design (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012), or more generally in the design literature. As such, this paper tests the potential of priming building on the logic of self-construal as a means of influencing users through artefact design, and more broadly, uniting individual and collective concerns (Kay, Wheeler, Bargh, & Ross, 2004; Kim, Yoon, & Gonzalez, 2012).

Unconsciously influencing the cognitive accessibility of norms connected to self-construal, and subsequently behaviour (Kay et al., 2004), through the physical design of an artefact has a number of advantages over traditional technologically facilitated approaches to behaviour change i.e. approaches utilising a direct intervention component e.g. persuasive technology (Kelders et al., 2012), or physically remove choice (Herring & Roy, 2007). First, unconscious interventions maintain freedom of choice rather than constraining behaviour (Steg & Vlek, 2009). Second, they can be deployed pervasively through the design of everyday products without requiring directed interactions with the user (DeMarree, Wheeler, & Petty, 2005). Third, such interventions can be used to subtly influence pro-social behaviour over the long term (Nurkka, Kujala, & Kemppainen, 2009), without compromising user experience (Tromp & Hekkert, 2016). Finally, despite validation in the psychology literature (Michie, Johnston, Francis, Hardeman, & Eccles, 2008; van Baaren, Maddux, Chartrand, de Bouter, & van Knippenberg, 2003) there is little guidance on how this type of intervention should be manifested in artefact design (Lehman & Geller, 2004; Wood & Newborough, 2003). This is despite the timely calls by Tromp et al. (2016; 2011) for designers in this domain to draw on all relevant approaches able to positively address conflicting concerns. Thus, this work addresses a key area complementary to current approaches such as Persuasive (Fogg, 2009) or Behavioural Design (Cash et al., 2017).

This paper experimentally tests the utility of influencing the user through product design, as well as testing the impact of priming the different senses open to interventions of this sort i.e. sight, hearing, touch, and smell. This is supported by a fully realised methodology using two sequential studies. The first transforms abstract associations into tangible design suggestions, while the second examines their impact with respect to a control condition. Throughout, an illustrative sustainability example is used.

## **1 Background**

This section outlines the current state of the art in behavioural design, before discussing self-construal and priming. In addition, the sustainability example used throughout the paper is introduced.

### **1.1 Behavioural Design**

The need for behavioural strategies, in addition to technical improvements e.g. making systems more efficient, is determined by three major factors. First, humans are driven by exogenous influences such as incentives and risks, and thus make biased decisions both consciously and unconsciously (Thaler & Sunstein, 2008). Second, many of these decisions are governed by intuitive and automatic unconscious processes that rely on associative reactions to situations (Kahneman, 2011). Third, behaviour driven rebound type effects can negate many of the benefits derived from technical efficiency improvements (Herring & Roy, 2007). Thus despite the importance of technology improvement, designers must also address human behaviour (Dolan, Hallsworth, Halpern, King, & Vlaev, 2014).

Based on this realisation a number of approaches have been described in the design literature. These have tended to focus on specific social theories or technologies, with varying degrees of applicability to unconscious processes. For example, although persuasive design and design for sustainable behaviour do not rule out unconscious effects (Bhamra, Lilley, & Tang, 2011; Fogg, 2009), they are not widely operationalized as highlighted by Kelders et al. (2012) and others (Lehman & Geller, 2004; Wood & Newborough, 2003). Specifically, persuasive design uses technologies to directly push interventions to a user, typically coupling motivational, enabling, and triggering components (Fogg, 2009). This approach is more generally supported by design for behaviour change (Wendel, 2013), which provides a number of design process suggestions. However, neither approach fully utilises the many different unconscious mechanisms underlying interventions e.g. priming. In response to this Tromp and Hekkert (2016) explicitly highlight the need to draw on a wider range of approaches in order to fully realise the potential of behavioural design. As such, Socially Responsible Design (Tromp, 2013; Tromp et al., 2011) helps to frame behavioural design projects, and directs designers towards the critical interface between individual and collective concerns; while Cash et al. (2017) provide guidance for designers seeking to incorporate different social and behavioural theories into their process. However, these works do not describe how specific mechanisms can be used to design artefacts able to dissolve conflicts between individual and collective concerns. In this context, priming, norms, and self-construal are key mechanisms that have been little explored in the design domain (Kim et al., 2012), despite their demonstrated importance in directing behaviour in the psychology literature (Cross & Madson, 1997; Cross et al., 2011).

### **1.2 Priming and Self-construal in Design**

In both design and social psychology there has been an increasing interest in using implicit stimuli to influence self-construal and behaviour through the design of everyday products (Kim et al., 2012; Thaler &

Sunstein, 2008; Visser, Vastenburg, & Keyson, 2011). For example, Thaler and Sunstein (2008, p. 6) define nudge as: *“any aspect of the choice architecture that alters people’s behaviour in a predictable way without forbidding any options or significantly changing their economic incentives”*. Here, priming is a key approach, first defined by Karl Lashley in 1951 as a *“temporary internal activation of response tendencies”* (Bargh & Chartrand, 2000). This impacts unconscious thought by targeting basic associations, such as, negative and positive valence (Williams & Bargh, 2008), the creation of stereotypes (Cox, Abramson, Devine, & Hollon, 2012), and social or behavioural norms (Kay et al., 2004). Priming, in this context, can be defined as the influence of a specific cue (e.g. text, sound or physical artefact) on a target, which activates an unconscious response. Priming works through implicit memory (Roediger, 1990; Schacter, 1992), and has been applied in, for example, neuro-marketing (Chartrand, Huber, Shiv, & Tanner, 2008; Fitzsimons, Hutchinson, & Williams, 2002). However, the specific impact of a priming intervention is critically linked to individuals’ self-construal (Michie et al., 2008; Zhang, Feick, & Price, 2006), which connects individual and collective domains (Cross et al., 2011).

Three features of self-construal make it an ideally suited framework for explaining how implicit priming type interventions can dissolve individual and collective concerns to deliver real world impact on social and behavioural norms. First, self-construal affects the way people relate to others and how they see themselves in this context (van Baaren et al., 2003). As such, it can be influenced by behavioural norms people associate with social interaction e.g. their perception of eco-behaviour as positive. Second, self-construal is susceptible to cues from the surrounding environment, making it ideal for implicit interventions instantiated in design artefacts (Ashton-James, van Baaren, Chartrand, & Decety, 2007; Zhang et al., 2006). Cues change the environment and situation to provide a trigger for changes in behaviour (Ouellette & Wood, 1998; Steg & Vlek, 2009). Third, self-construal is linked to perceived social and behavioural norms, which have a strong effect on how people behave in certain situations (Cialdini, 2007; Kay et al., 2004). Here, it is not necessarily what others do, but what people think they do, that has an effect on a persons behaviour (Cialdini, 2007; Lockton, Harrison, & Stanton, 2008; Schultz, Oskamp, & Mainieri, 1995). This provides an opening for interventions to link to perceptions of collective concerns in the form of social and behavioural norms. These features make self-construal an ideal lens for understanding conflicts between individual and collective concerns in design (Tromp & Hekkert, 2016; Tromp et al., 2011). In particular, the triggering of social and behavioural norms through environmental cues opens the door for designers to influence users through everyday objects (Kay et al., 2004), and fulfil both individual user and collective demands.

Although Michie et al. (2008) and others (DeMarree et al., 2005; Wheeler, DeMarree, & Petty, 2007) have shown the importance of priming as a vector for influencing behavioural norms via self-construal in other fields, this is a relatively new area of interest in design (Crilly, 2011; Visser et al., 2011). For example, Crilly

(2011) highlights that without continuous nudging or other persuasion people will often act against their own long term interests, either social or economic. Thus the potential for embedding priming in everyday design holds significant scope for delivering sustained influence by shifting associations with behavioural and social norms. Exploring this approach further, it has been shown that priming stimuli can be designed into the fundamental structure of the object (Kay et al., 2004). The main advantage of this is that incorporating stimuli into an artefact's design reduces the likelihood of conscious recognition. This is crucial as awareness of the stimuli negates much of the impact, mitigating many of the benefits of using implicit interventions (Bargh & Chartrand, 2000). For example, people aware of the stimuli may take countermeasures to prevent the desired outcome (Bargh & Chartrand, 2000). This is in contrast to persuasive design and other current design approaches where users are presented with stimuli and a choice of actions – including counteraction (Herring & Roy, 2007). By maintaining implicit unconscious effect priming promotes behaviour change without constraining freedom of choice or suffering from rebound type effects.

The majority of research on priming type interventions has taken place in the social science, psychology, and marketing literatures. In the social and psychological context, there has been a focus on exploration of mechanisms and the phenomenon itself (Ashton-James et al., 2007; Ijzerman & Semin, 2009), with little discussion of practical implementation in artefact design and real world impact on behavioural and social norms. In contrast, the marketing literature has focused on applied branding and purchasing related research (Fitzsimons, Chartrand, & Fitzsimons, 2008; Peloza, White, & Shang, 2013), with limited discussion of conflicting individual and collective concerns. Further, the focus on branding is reflected by the types of interventions evaluated in this domain i.e. often instantiated in symbolic logos and heavily biased towards visual cues (Mazar & Zhong, 2010). As such, only limited insights are available to the designer seeking to dissolve conflicting concerns through artefact design. This leaves two specific needs to be addressed in this work. First, to test the operationalization of priming interventions via the design of artefacts rather than via branding or symbolic communication. Second, to examine this effect across the major senses available to a designer: sight, hearing, touch, and smell.

To give a better understanding of current research on priming across different senses a review of recent works in this area was undertaken. Nineteen journal papers from the last ten years were identified, reporting a larger number of individual studies. The full list of citations, senses targeted, stimuli used, and overall results are provided in the appendix. Three main conclusions can be drawn from this review. First, the vast majority of studies deal with visual stimuli linked to either abstract images or brand elements such as logo's. Few studies used interventions instantiated as part of the artefact itself. Second, very few studies dealt with senses other than sight, and fewer still offered comparison between senses. Specifically, only Tropeano (2006) compared sight and hearing via a controlled study. Two studies were found that

compared hearing and smell (Mattila & Wirtz, 2001; Morrison, Gan, Dubelaar, & Oppewal, 2011), however these did not report control conditions and are thus not included in the review summary in the appendix. Third, meta analysis across senses was not possible due to the variety of measures and mechanisms being addressed. However, the overall results suggest that each sense type is viable. This gives rise to a number of design suggestions, described below:

- In order to affect automated behaviour, the behaviour needs to be embedded in the automatic system of the brain to begin with (Bargh, Chen, & Burrows, 1996). Priming type interventions cannot influence behavioural patterns in areas that are unfamiliar to the subject (Fitzsimons et al., 2008).
- In order to promote a specific behaviour, the end state of the behaviour must have positive associations for the subject. An end goal that is negatively perceived by the subject will not be successfully adopted (Fitzsimons et al., 2008). This links self-construal and perception of social and behavioural norms.
- To be effective the impact on the subject must be implicit and relevant. The context should, as such, be both relevant and ambiguous to ensure freedom of choice (Kay et al., 2004).
- The effect of priming type interventions is reduced with repeated behaviour i.e. if a subject is primed with the goal of behaving honestly, the effects of this prime will only be apparent in the immediate next behaviours (Chartrand et al., 2008). After facing a task within the target area of the priming, subjects show significantly decreased effects of the stimuli in subsequent tests also within the target area, unless successfully exposed to the prime again (Chartrand et al., 2008).
- Differences in the application and impact of priming across various senses is not well described, however, current literature suggests all senses can be used to successfully deliver implicit interventions (see appendix).

### **1.3 Sustainable behaviour example**

In the context of this work, sustainability offers an excellent example because of its global importance and the widely recognised social and behavioural norms e.g. reducing waste. Further, numerous authors have highlighted that despite years of technological advancement in both products and feedback strategies, further increases are yet to be realised via sustainable behaviour (Abrahamsen, Steg, Vlek, & Rothengatter, 2005; Consolvo, McDonald, & Landay, 2009; Ghaemi & Brauner, 2009; Lilley, 2009). In particular, in the context of everyday residential energy consumption, people are generally unaware of their behaviour and the subsequent sustainability consequences (Wood & Newborough, 2003). As such, it can be concluded that people often use automatic behaviour in this context. This manifests as habits and unconscious routines, making behavioural design using priming to target self-construal particularly applicable in this case (Pierce, Schiano, & Paulos, 2010).

## 2 Methodology

Based on the above criteria it is possible to formulate a research framework (Dorst, 2008), where priming stimuli instantiated in a designed artefact influence behavioural norms via self-construal, as a precursor to real world behaviour change (Cross, Morris, & Gore, 2002; Voyer & Franks, 2014). This framework follows the logic:

1. Certain cues are unconsciously associated with aspects of self-construal (Ferraro, Bettman, & Chartrand, 2009). For example, rounded shapes have been shown to be connected to interdependent self-construal, while angular shapes are connected to independent self-construal (Zhang et al., 2006). These in turn are connected to real world changes in activation of social and behavioural norms (Kay et al., 2004).
2. Cues can be derived by identifying unconscious associations between either interdependent or independent self-construal and other constructs (Cross et al., 2002). For example, increased interdependent self-construal can be cued by exposure to connected shapes, which in turn increases the likelihood of accessing norms associated with e.g. sustainability (Kim et al., 2012).
3. As self construal connects an individual's self perception to collective behavioural and social norms (Cross et al., 2002), it fundamentally connects individual and collective concerns (Tromp & Hekkert, 2016). Thus individuals exposed to interdependent cues should show increased activation of social and behavioural norms with respect to behaviours that are good for both the individual and the group (Kim et al., 2012).

Based this logic the evaluation of intervention effectiveness builds on the assessment of participants' activation of social and behavioural norms that balance individual and collective concerns e.g. acting sustainably or reducing excessive consumption. If activation is increased by the treatment intervention in comparison to the control, and no hypothesis awareness is identified then the intervention is considered a success. This relationship and the associated variables are outlined in Figure 1. Major confounds are participant awareness and experimental bias (Gephart & Antonoplos, 1969; Kirk, 2009). Thus a control was used to eliminate experimental effects (Cash & Culley, 2014; Kazdin, 1998), and hypothesis awareness was used as a check variable.



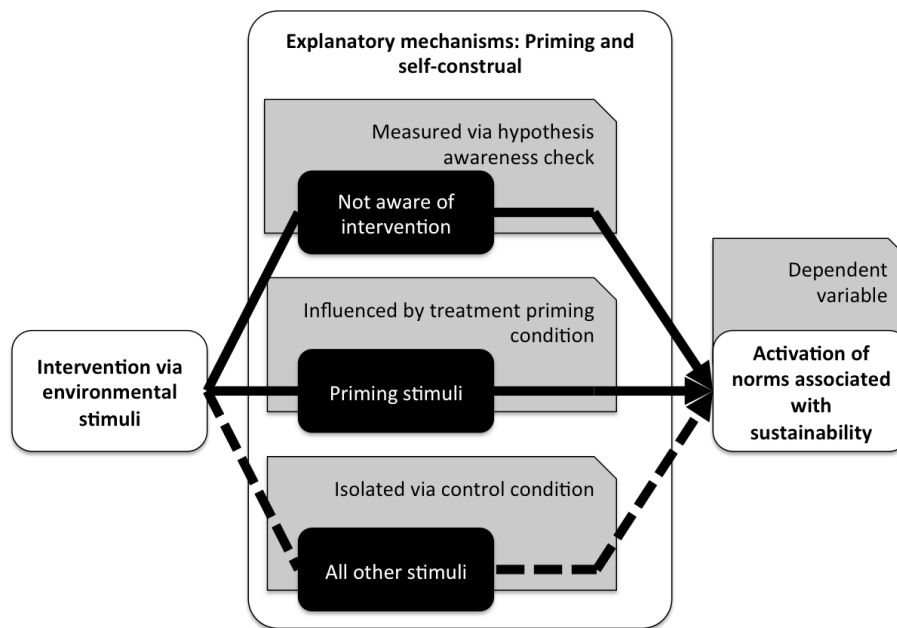


Figure 1: Research framework

Two main hypotheses are derived from this framework.

**H1:** Artefacts embodying sustainability priming cues will affect activation of social and behavioural norms surrounding sustainable behaviour in comparison to a control.

**H2:** Priming cues will affect activation of social and behavioural norms across all senses.

## 2.1 Research process

Various methods for conducting priming studies exist. However, there are few that specifically explore priming interventions from the perspective of design. In the context of this work conceptual priming is the most relevant source for methodological insight. Here, participants are first exposed to the prime (the treatment intervention), and then the effects of the priming are subsequently assessed in a second, seemingly unrelated test (here concerned with behavioural norms) (Bargh & Chartrand, 2000). The priming intervention in these studies can be either subliminal or supraliminal.

In subliminal interventions, priming objects are subliminally shown (e.g. flashed on a computer screen for a few milliseconds) such that the test subjects are not consciously aware of the stimuli (Bargh et al., 1996; Fitzsimons et al., 2008). Although this is a viable approach it is less relevant in the context of artefact design. In supraliminal interventions participants engage with a word, text, sound or object containing the priming stimuli, which are presented without revealing the purpose of the study (Berkowitz & LePage, 1967; Ijzerman & Semin, 2009; Kay et al., 2004). In this context, it is critical that the derived supraliminal cues are reflective of the population in which they will subsequently be deployed (Cross et al., 2002), as well as associated with the targeted social and behavioural norms (Section 2). For example, if the target

population is the average British citizen, then the cues should also be derived directly from this group. Thus a supraliminal approach is adopted, following the three main steps described below and illustrated in Figure 2:

- (1) If cues are not known (as in most design cases) the first phase is to identify cues associated with the subject by the target population. This was achieved distilling unconscious associations with sustainability from the target population in the form of generic representations (Section 3).
- (2) The representations from (1) are transformed into abstract design cues that can be integrated with a product. This was achieved by carrying out a grounded analysis of the representations from (1) in order to identify common design cues (Section 4).
- (3) The utility of the designs from (2) are tested following the research framework (Figure 1). This was primarily measured using a sentence completion test for the dependent variable (Section 5).

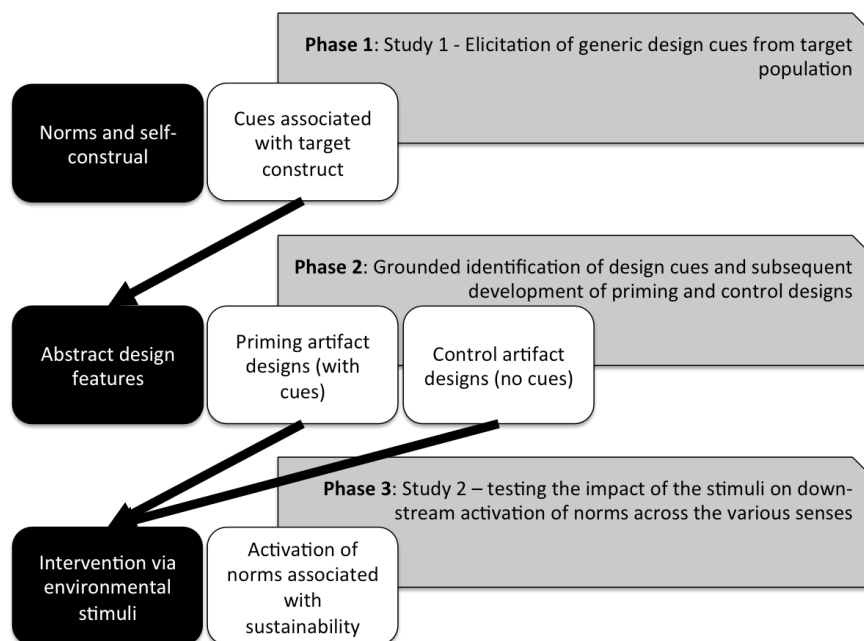


Figure 2: Overview of methodology detailing the various research phases

### 3 Phase 1: Study 1 – Elicitation of design cues

Study 1 aimed to elicit the design cues associated with sustainability by the population to be targeted in Study 2 (Section 2). This forms the first major task in intervention development when unconscious cues are not known. Although design experts have produced numerous proposals for artefacts that ‘embody’ sustainability these have generally been derived through traditional design processes and there is no guarantee that they actually trigger the desired associations in the target population. As such, distilling associations directly from the target population forms a critical first step, even when the design space is

well populated. The study asked participants to draw logo suggestions or list words they would associate with the company slogan “*Be Sustainable*”. This study was split into visual and non-visual subsets. See the appendix for the full protocol.

### 3.1 Population and sample

The sample in Study 1 was split into two groups, one for visual (51 participants), and one for non-visual (46 participants). All of the participants were students with basic training in sketching and communication of ideas, making them ideal for a study of this type. All of the participants were Danish, and had no previous professional experience within the field of engineering. This sample was used because the basic sketching training meant that the participants would be able to conceptualise and communicate their sustainability ideas fluently (utilising System 1 thinking) without being overly biased by prior experience or specific training. Further, the representative nature of the sample ensured that the cues derived would be linked to the population to be targeted in Study 2. This latter aspect was important for generalizing the cues elicited to the wider population included in the follow up study. It is important to note that the design cues are connected to social and behavioural norms, and thus ecological validity of the sample must be considered (Cross et al., 2011). As such, using expert designers would not be appropriate, as they do not represent the wider target population i.e. the general public in Denmark, used in Study 2.

### 3.2 Method

The study was set up as a regulated session where the participants were asked to generate visual or non-visual ideas for a company with a particular slogan. This approach has been demonstrated as effective by e.g. Kim et al. (2012) in the design domain. A five-page booklet was given to the participants to record the results from the study in a uniform format. The booklet included the study brief on the front page. The slogan was accentuated in the written brief and was also placed at the top of each page, reminding participants about the aim. The slogan “*Be Sustainable*” was used, as it resembles traditional company slogans and relates to behaviour in the active formulation compared to e.g. “*Sustainable*” or “*Sustainability*”. Finally, all participants were instructed to complete the test individually, and to focus on quantity of ideas. This demand and limited time aimed to promote System 1 thinking (Kahneman, 2011). The two tasks were:

**Visual:** sketch logos using abstract and geometric shapes. Abstract logos were requested, as they allowed for more direct translation to products able to be subtly integrated into a real world environment. Use of letters, words, symbols, and numbers was discouraged in order to focus participants on visual representations. No constraint was placed on logo colour, as this was not considered in the coding or artefact development. Colour was excluded as it has been shown to have independent effects of cognition

and behaviour (Mehta & Zhu, 2009). In this condition the booklet pages following the brief were divided into four squares with room for a unique logo idea in each. Participants were given 10 minutes.

**Non-visual:** list words associated with hearing, smell, and touch as a direction for logo and company branding. Words associated with logo and brand were requested in order to align this exercise with the visual results. In this condition the booklet pages following the brief were divided by each of the senses considered (hearing, smell, touch). Participants were given three minutes for each sense as well as a short break between each, totalling 10 minutes.

In order to maintain hypothesis blindness, a cover story was used (Boland et al., 2001; Luck, 2007). Participants were told that in the session they would be regarded as *'brand designers headhunted by a company to come up with ideas for a new company logo'*. The brief for the task was kept simple and an emphasis was placed on each suggestion being illustrative of the slogan. Participants were also informed that company name and type of goods/services produced was not relevant to the given task. These criteria thus helped ensure that the elicited associations between shapes/words and sustainability were valid automatic responses.

### 3.3 Coding

The visual logo suggestions were compiled and sorted into three categories based on level of abstraction:

**Abstract:** logos not including any concrete references to everyday objects, text or numbers, and primarily geometric and organic shapes not associated with tangible sustainable representations.

**Symbolic:** logos using concrete references to identifiable objects or representations of everyday things. These logos were excluded from the study, as they were not suitable for priming type interventions where representations need to be implicit and ambiguous.

**Mix of abstract and symbolic:** logos mixing symbolic and abstract elements. Although these logos were not used as the basis for Study 2 the abstract parts were considered as a robustness check for the results from the abstract group.

Although all participants were asked to avoid specific symbolic references these still comprised a portion of the responses and were thus identified so that they could be removed from consideration. With the intention of producing design guidelines for subtle product features, necessary for Study 2, the remaining logos were further sorted using a number of bipolar adjectives. These adjectives were formulated to describe the main visual characteristics in the logos and included considerations of e.g. overall shape and repetition. Six sets of bipolar adjectives were defined and described based on a grounded survey of the logos, as there are no extant guidelines.

Due to the text based nature of the non-visual suggestions they were grouped based on semantic similarity, using the following rules:

**Same word:** suggestions have the same meaning e.g. 'flower' and 'flowers'.

**Same concept:** suggestions have the same general meaning e.g. 'flower' and 'rose'.

**Related concept:** suggestions are closely linked e.g. 'grass' and 'lawn'.

In addition to these grouping conditions suggestions were eliminated when they were either too general to categorise or had no or negative relation to any of the three senses considered. Suggestions were eliminated when they were:

**Too general:** the meaning of the suggestion is not clear in terms of a sense e.g. 'nature' has multiple possible instantiations in each of the senses.

**Too abstract:** the suggestion is not directly relatable to a sense e.g. 'pleasant'.

**Not/negatively related to a sense:** the suggestion describes something that can be sensed but is not related to the selected senses e.g. mass or temperature; or describes something that is negatively related to the concept e.g. pollution.

As with the visual suggestions the non-visual results were related to specific cues that could be realised in a product design in order to proceed to Study 2.

### 3.4 Results

The total number of logos received from the 51 visual participants was 277. Of these 277, 76 were abstract, while the rest were a mix of abstract and symbolic (81) or purely symbolic (120). Those logos with symbolic elements were excluded. Table 1 summarises the categorisation of the abstract and, mix of abstract and symbolic logos using the bipolar adjectives.

The three most frequent characteristics were 'Rounded' (77.7%), 'Continuous' (61.2%) and 'Enclosed' (86.0%). These characteristics were identified because a substantial difference was found from their opposing traits. As such, only these three characteristics were used as guidelines for designing the priming objects. Of the total 76 abstract logos, 38 incorporated all three characteristics and were used as the main inspiration for the priming objects. Frequency was used as the primary measure at this stage due to the focus on identifying those characteristics most widely associated with sustainable behaviour. Further, as each suggestion typically consisted of only one or two features, assessing comparative prominence was considered inappropriate. An intercoder reliability check was used to validate the logo classification. This gave an agreement of 88%, which is considered acceptable (Lombard, Snyder-Duch, & Bracken, 2002).

Table 1: Summary of the categorisation of logos using bipolar adjectives

Categories	No. of abstract logos	No. of mixed abstract and symbolic logos	Total No of logos	Percentage
Rounded	51	71	122	77.7
Angular	25	10	35	22.3
Continuous	47	49	96	61.2
Discontinuous	29	32	61	38.5
Repeated Pattern	38	37	75	47.8
Not Repeated Pattern	38	44	82	52.2
Arrows	23	38	61	38.9
No Arrows	53	43	96	61.2
Enclosed	64	71	135	86.0
Open	12	10	22	14.0
Explicitly Invokes Nature	3	75	78	49.7
Does Not Invoke Nature	73	6	79	50.3

The total number of words received from the 46 non-visual participants averaged approximately 500 for each sense. The responses for each sense displayed an exponential drop off, giving a clear top five associations with a long tail of other suggestions. Table 2 summarises the top five word groups associated with each sense. The top three in each sense were taken forward as the basis for cue development (Section 4). An intercoder reliability check was used to validate the classification. This gave an agreement of greater than 80% between two of the involved researchers and an independent third party (Lombard et al., 2002).

Table 2: Summary of most popular word groups for each sense

	Top five cues	Total No of words
Hearing	A whistling wind	35
	Bird life	25
	The ocean	23
	A stream of water	17
	Rain	14
Smell	Flowers	30
	Grass	25
	The ocean	20
	Trees	18
	Forest	14
Touch	Rough stone	37
	Wood	23
	Grass	17
	Bark	14
	Water	14

#### 4 Phase 2: Design of the priming and control stimuli

Building on the associations identified in Study 1 priming stimuli were created. For hearing, smell, and touch this was accomplished by directly creating a stimulus based on the main associations for each sense (Table 2) e.g. an ambient audio recording of ocean waves, or a scent provided by cut grass. For these non-

visual senses such elements could be directly incorporated with a product's design e.g. adding a wood bark surface texture. Hence, non-visual elements were separated from the overall product and tested as isolated product features e.g. surface finish or deliberate scent. This reduced the possibility of confounding variables being introduced via the activation of multiple senses simultaneously. However, in the visual context additional work was required in order to translate the associations into visual priming stimuli. This was achieved by synthesising the abstract logos that contained the traits rounded, continuous, and enclosed, into four groups as shown in Figure 3. Although, these groups are connected to features typically associated with sustainability, it was essential to distil them directly from unconscious associations within the population in order to ensure their validity. As such, Study 1 provided an essential step in connecting the priming stimuli to the associations understood by the population.

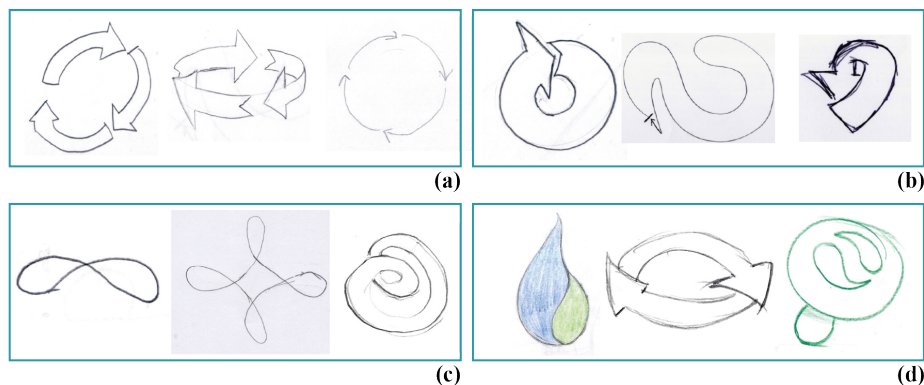


Figure 3: Common visual traits categorised into four overall groups: (a) Multiple arrows in closed loop (b) One arrow in closed loop (c) Loops and knots (d) Intertwined elements

The visual stimuli were designed by the authors based on the sketches from Study 1 and the existence of equivalent real world designs. It is also worth noting that of the 38 logos that were rounded, continuous, and enclosed, arrows were a repeating element. However, no arrows are included in the final artefacts. Arrows were excluded and shapes kept abstract in order to avoid any unintended associations. The dominant shape characteristics were thus translated into three everyday products embodying the visual stimuli. For the control stimuli comparable yet neutral (with regards to sustainability) products were created (Cash, Elias, Dekoninck, & Culley, 2012; Stewart-Williams, 2004). The comparison between the visual characteristics of the different conditions is illustrated in Figure 4. All of the designs were linked to analogous real world products, ensuing that they were similarly believable. This was important given the primary measure (Section 2) and the aim of simulating interaction with real products. Further, there is a plausibility requirement for the different conditions. For example, if prototype products were used a number of confounding variables would be introduced by the rough nature of a prototype, particularly given 'rough' was a common term associated with touch in Study 1. Similarly, if real products were used a number of possible confounds are introduced via e.g. brand recognition (Fitzsimons et al., 2008).

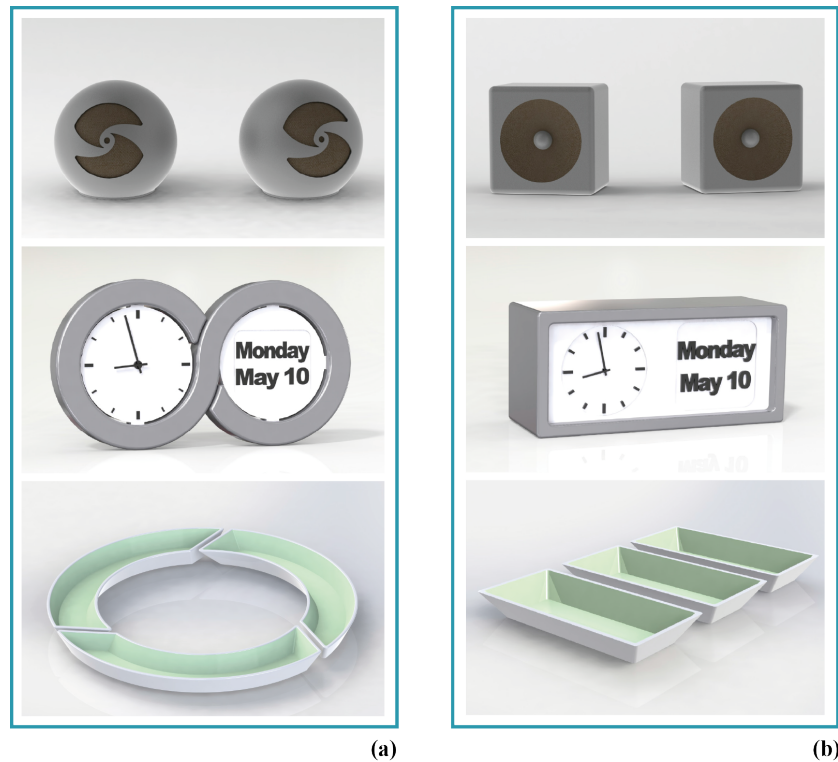


Figure 4: Overview of visual priming and control products: (a) Priming products (b) Control products

## 5 Phase 3: Study 2 – Stimuli testing

Study 2 aimed to test if participants could be primed to exhibit greater activation of social and behavioural norms that balance individual and collective concerns through exposure to the stimuli distilled in Phase 2 (Section 4) following Kay et al. (2004). The study used a conceptual priming design with four priming (visual, hearing, smell, and touch) and one control condition (Bargh & Chartrand, 2000). The primary measure used a written sentence completion test based on previous studies in this area (Abbate, Ruggieri, & Boca, 2013; Holaday, Smith, & Sherry, 2000; Kay et al., 2004). The purpose of Study 2 was to test the effectiveness of the interventions in comparison to the control condition and each other (Section 2).

### 5.1 Population and sample

The sample in Study 2 consisted of 210 participants (40% female, mean age = 24 years). 78% came from Denmark while 22% represented a mix of nationalities, mainly from Europe. All international participants completed the test in English while local participants completed the test in their national language. The test protocols were made in both English and Danish, and cross translated to ensure consistency. Participants from Study 1 were not allowed to participate in Study 2. Participants were recruited from different sources across Denmark in order to provide greater reliability. In this context, the population was similar in age and composition to that of Study 1. As the purpose of this study was to test the effectiveness of the



interventions, and not to test the impact of interventions across the whole demographic spectrum this population was appropriate for addressing the hypotheses outlined in Section 2.

## **5.2 Method**

The design of the study and assessment method were based on an analysis of the studies reviewed in Section 2 (also see the appendix), drawn from journals covering Psychological Science, Social Psychology, Marketing, and Consumer Behaviour. Further, a pilot study was carried out with two principal tasks: (1) to train the experimental facilitators, ensuring consistency, and (2) to check the sentence completion test and possible hypothesis awareness. The pilot study was conducted with ten participants prior to the main study.

## **5.3 Process**

As with Study 1 a cover story was used to maintain hypothesis blindness. This is typical of priming studies where blindness is critical to the validity of the results (Bargh & Chartrand, 2000). All participants were told that the experiment consisted of two separate studies: a cognitive test using an adjective task, and an opinion survey using a sentence completion task. Participants were then randomly assigned to either a priming or control condition. 60 participants were associated with the visual stimuli and control conditions, while 30 were used for each of the other senses. This distribution was used because visual stimuli and the control formed a baseline for comparison, being most directly product related. Statistical power analysis also showed that all groups were sufficient for the results to be meaningful. Participants in the priming conditions were exposed to priming stimuli, while those in the control condition were exposed to the neutral products/product features (Figure 4b).

Once assigned a condition, the experimental facilitator read the study brief to the participant to ensure understanding and consistency (see appendix). Participants were then exposed to the intervention. For the visual stimuli the product images were shown in sequence on a computer, and participants were instructed to write three adjectives for each. No time limits were given and an answer sheet with large product thumbnails was used to record the results. This procedure was the same for the other senses, except participants were blindfolded and asked to smell/listen/touch the stimuli. Upon completion the answer sheet was collected and the instructions for the second part of the study were read to the participant. It was emphasised that the sentence completion test should be done as quickly as possible and without thinking about the answers. Having confirmed understanding of the task, participants were given a sheet with 15 unfinished sentences to complete. The sentence completion test was chosen over a word completion test (Toth, 2000) in order to mitigate any confounds associated with English language proficiency. The sentences in the test were formulated to invoke future action and were constructed using 'I', 'Me' or 'My' in order to focus participants on their own future behaviour. In particular these were

selected to provide a measure of activation of social and behavioural norms following (Figure 1) e.g. Kay et al. (2004) and (Abbate et al., 2013). All sentences were framed with respect to actions/desires balancing individual and collective concerns (Tromp & Hekkert, 2016). Once complete, general information questions were used to gather demographic data. Finally, the study was concluded with a funnelled debriefing (Bargh & Chartrand, 2000) consisting of five questions assessing participant hypothesis blindness. All questions, as well as the full protocol for both studies are included in the appendix.

## 5.5 Coding scheme

When coding the results hypothesis and condition blindness was crucial to eliminating experimental effects, particularly confirmation bias (Rabin & Schrag, 1999). As such, a strict randomisation and anonymization procedure was used to ensure coder blindness. Once randomised, coding was based on an assessment of sustainable responses, related to activation of social and behavioural norms. Results were found to be associated with four overall behavioural norms 'Energy reducing', 'Consumption reducing', 'Reuse enhancing', and 'Environmentally aware shopping', however, all sustainable answers were considered on a grounded basis:

**Sustainable answers:** Answers that were explicitly sustainable and showed a clear activation of social and behavioural norms associated with sustainable actions, sustainability and collective concerns in this area generally e.g. *"I would like to limit my consumption of CO<sub>2</sub>"*

**Non-sustainable answers:** Answers that were not obviously linked to sustainable behaviour or sustainability norms e.g. *"I hate it when people waste my time"*. This also included answers that did not explicitly show a heightened awareness of sustainability, but could be interpreted as such e.g. *"I think people should be more ethical"*.

An intercoder reliability check revealed a 95% agreement between four coders. The remaining 5% was agreed on collectively before moving on to the analysis of the results.

## 5.6 Statistics

The hypotheses of the study are one-directional, with the null hypothesis being that there is no difference between the conditions (prime and control). This is explicitly based on prior theory where effects are expected across all the senses considered (Section 2). As such, analysis focused on results distributed on one side of the null hypothesis. Therefore, a one-tailed statistical test was used (Walker, 2010). Further, as the results were not normally distributed, the most appropriate statistical test was the non-parametric Mann-Whitney U test (Hart, 2001). A series of robustness checks were also carried out where the data was evaluated using a one-tailed students t-test, as well as two-tailed versions of both the Mann-Whitney U and t-test. In addition statistical power was checked for all groups.

## 5.7 Results

The subject specific variable in this test was the number of answers (out of 15 sentence completions) that were related to activation of social and behavioural norms associated with sustainability. For both conditions the number of sustainable answers was in line with prior works e.g. Kay et al. (2004). Collectively primed participants had a mean of 1.55 (10%) and control participants 0.90 (6%) sustainable answers (difference = 0.65/4%). This resulted in a small but significant difference supporting the hypotheses  $p = 0.0008$  (one-tailed Mann-Whitney U; t-test  $p = 0.0002$ ) (Walker, 2010). These results show that the primed subjects exhibited greater activation of social and behavioural norms associated with sustainable behaviour after exposure to the cues. Although this difference is small the statistical power checks showed it to be robust (power = 0.97 for  $n = 60$ ). As such, despite the small differences observed the results are significant and meaningful with respect to the proposed hypotheses.

Each individual sense also showed a significant improvement over the control (power greater than 0.8 for  $n = 30$ ,  $p < 0.05$ ). However, no significant differences were found between the senses. Table 3 outlines the results.

Table 3: Summary of results across all senses

	Control	Prime conditions			
		Visual	Hearing	Smell	Touch
n	60	60	30	30	30
Mean	0.90	1.32	1.70	1.53	1.63
SD	0.98	1.08	1.47	1.20	1.52
Prime v. control					
Improvement	-	2.8%	5.3%	4.2%	4.9%
Significance	Mann-Whitney t-test	$p = 0.0154$ $p = 0.0147$	$p = 0.0048$ $p = 0.0050$	$p = 0.0078$ $p = 0.0079$	$p = 0.015$ $p = 0.010$

## 6 Discussion

The results from Study 2 show a significant effect and thus answer the posed hypotheses as follows:

**H1:** Artefacts embodying sustainability priming cues will affect activation of social and behavioural norms surrounding sustainable behaviour in comparison to a control. **Supported**

**H2:** Priming cues will affect activation of social and behavioural norms across all senses. **Supported**

### 6.1 Realising priming through design

This work supports and extends existing studies by evaluating the effect of priming on activation of behavioural norms and directly comparing this effect across different senses.

Focusing on the first contribution, the demonstration of enhanced activation of behavioural norms associated with sustainability illustrates the potential value of priming in this context. Further, the observed effect on norms points to the possible value of self-construal as an explanatory mechanism connecting artefact based priming to social and behavioural norms, in the context of conflicting individual and collective concerns. In this context, the results provide a platform for further work deconstructing the mechanisms underpinning the activation of behavioural norms and self-construal effects in design. In particular, Kim et al. (2012) list a number of traits associated with an interdependent self-construal, which includes pro-social behaviours, and a tendency to engage with the social context. These were repeatedly found as the major indicators of activation of behavioural norms in Study 2's sentence completion test. This links to Zhang et al.'s (2006) work, which associated interdependent self-construal with a preference for rounded shapes (specifically picture frames). Further, as self-construal theoretically integrates individual and social perspectives with respect to behaviour (Cross et al., 2002), this provides a potential explanation for how conflicting concerns can be resolved when applying design interventions developed through e.g. persuasive design (Fogg, 2009) or design for sustainable behaviour (Bhamra et al., 2011). Thus the results reported here extend and elaborate those of Kim et al. (2012) and point to the need for further theoretical and empirical work in exploring the systematic operationalization of self-construal in design, particularly in support of Socially Responsible Design (Tromp et al., 2011) and Behavioural Design (Cash et al., 2017).

Focusing on the second contribution, this study constitutes the first work in the design domain to directly compare the impact of priming effects across the different senses, bringing together the diverse literature identified in Section 2 (also see the appendix). Despite the small size of the change in response between prime and control conditions the results were significant and in line with prior studies utilising similar measures in the context of priming. For example, the difference in means found in Kay et al.'s (2004) study utilising a word-completion test was also in the order of 4%. However, this highlights the need for priming type interventions to be complemented by other means of behaviour change, such as direct technologically facilitated interventions (Kelders et al., 2012), or efficiency improvements (Herring & Roy, 2007). Further, although there were no significant differences found across the senses the effect size was slightly greater in the non-visual conditions. This is likely due to the more focused nature of the interaction with the non-visual cues i.e. participants did not see the artefact and were thus faced less distractions in terms of competing cues. For example, in the visual condition, the metallic colouring of the speaker cue could cue an association with non-natural substances such as metal or plastic. As such, although the results support the two main hypotheses, it is likely that as additional elements are added, such as branding, the effect size will be reduced. As such, the study reported here serves to expand the possible scope of behavioural design beyond the direct approaches typically associated with persuasive interventions (Fogg & Hreha, 2010; Kelders et al., 2012), and beyond the typically visual cues used in prior studies (Section 2). This has been

highlighted as a key step towards more holistic design for behaviour change in the social context (Cash et al., 2017; Tromp, 2013), where multiple behavioural theories can be applied (Francis et al., 2009; Michie et al., 2008). However, further work is needed to determine how a priming affect might be sustained over time in order to support long term behaviour change and habit formation (Verplanken & Melkevik, 2008).

Finally, the next major step in this area is closing the loop from intervention to sustained behaviour change, as well as further exploration of the possible role of self-construal in dissolving conflicting individual and collective concerns. For example, Dahlstrand & Biel (1997) discuss how habits are a key determinant in environmentally friendly behaviour, while others note that habit formation has been relatively unexplored in behavioural research (Verplanken & Melkevik, 2008). With respect to this work, a critical factor in habit formation is goal intention (Ouellette & Wood, 1998; Verplanken & Melkevik, 2008), which links long term behaviour change to self-construal, social and behavioural norms, and automaticity (Tang & Bhamra, 2008; Verplanken, 2006). For example, Jelsma (2006) explains that behaviour is driven by intentions, attitudes, and values but that practices from everyday life are deeply embedded in routines and habits. However, this type of directed habit formation through product interaction is an open and challenging area of research with little explicit guidance for designers (Wood, Witt, & Tam, 2005). Further, Crilly (2011) rightly highlights the need to consider alternative perspectives on persuasive interventions, such as the inferences users make about the designers' real intentions.

## **6.2 Ethical considerations**

Although ethical issues are not the focus of this work, it is impossible to discuss behavioural design without also considering ethics. In particular there are a number of possibilities for ethical abuses even where the designer is well intentioned. As such, there is a need for a continuous and open debate on the ethical use of persuasive approaches (Oinas-kukkonen & Harjumaa, 2008). Here the ultimate aim is to build on informed consent. However, this is difficult to achieve without damaging the unconscious affect mechanism. In this context we recommend the work of Berdichevsky and Neuenschwander (1999) who lay out ethical guidelines applicable to all persuasive approaches.

In this work ethical issues were considered explicitly at each stage of the research process, and each study was discussed with an external group of academics to ensure ethical compliance. In particular, all participants were volunteers. Further, due to the nature of priming interventions the effects are not long term, thus impact on individual participants was controlled. However, when aiming for longer term change explicit consent must be sought. It is impossible to overstate the importance of ethical compliance and transparency in this domain, particularly given that public trust underpins efforts to role out behavioural interventions for societal change.

## **7 Implications and limitations**

There are a number of important implications for both design researchers and practitioners from this work.

### **Implications for design research**

First, artefact-based priming through product design can be used to effectively influence users, although there are a number of research questions remaining unanswered. This adds a new dimension for influencing user behaviour by bridging implicit interventions and product design, explicitly addressing a gap in current design support (Kelders et al., 2012). Second, self-construal holds significant potential, as a mechanism for explaining design interventions targeted at influencing the activation of social and behavioural norms surrounding conflicting individual and collective concerns. This directly links to and supports Tromp and Hekkert's (2016) call for greater efforts in supporting pro-social design across a range of theoretical platforms.

### **Implications for designers**

First, this work describes a viable approach for eliciting, and subsequently utilising priming stimuli in a design context. Second, two key considerations for future design work focused on behaviour change are highlighted: synthesis of individual/collective concerns and the activation of social and behavioural norms. These expand the range of considerations that should be addressed when developing a product and explicitly point to new areas of opportunity in product design. Finally, Study 2 highlights the fact that significant effects were achieved across each of the targeted senses: sight, hearing, smell, and touch. This expands the design space when considering the development of priming products.

## **7.1 Limitations**

First, in terms of study design there were two key considerations: hypothesis blindness, and balancing relevance verses ambiguity in the sentence completion test. Results from the funnelled debriefing indicated total hypothesis blindness across all participants. This suggests that the intervention did indeed achieve its supraliminal objective. In terms of balancing relevance and ambiguity the sentence completion test was specifically formulated to focus the participants' on their personal opinion with respect to a number of everyday topics e.g. public transportation. Further, sentences evoking sustainable behaviour were mixed in with a range of social topics that could all be answered with respect to interdependent behavioural norms. This maintained the relevance to the participant whilst disguising the true aim of the study. Finally, the sentence completion test was relatively short compared to common tests of a similar nature used in psychology studies (Holaday et al., 2000). While these analyses are longer (e.g. the 'Rotter Incomplete Sentences Blank' (RISB) has 40 sentences) priming necessitates a shorter design (Chartrand et al., 2008). As such, the test was considered an appropriate length, particularly given the significance of the results, and their alignment with prior work (Kay et al., 2004).

Second, based on this study and the related works by Kim et al. (2012), and Zhang et al. (2006) priming through the design of everyday objects shows clear potential for affecting behaviour. However, as noted in the discussion there are substantial differences between experimental and real world contexts. Thus, although this work moves the field forward it also serves to highlight the need for further work in translating priming interventions into long term behaviour change. In particular the design of behaviour experiments is a critical next step in exploring and validating this area as a useful tool for behavioural designers.

## **8 Conclusion**

The presented work has experimentally validated the use of artefact based priming across different senses (sight, hearing, smell, and touch), to influence users' activation of social and behavioural norms that balance individual and collective concerns. In this context, it adds to and complements technical strategies, such as, persuasive design, highlights new possibilities for behavioural design, and suggests a potential means of explaining and resolving conflicts between individual and collective concerns.

There are significant implications for both researchers and design practitioners based on this work: the potential for dissolving conflicts between individual and collective concerns; and extending the scope of possible behavioural design interventions across the various senses. However, there is a need for further work to integrate these behaviour change strategies with wider design practices, and to define the role of priming type stimuli in supporting longer-term behaviour change. In terms of behaviour and habit formation further work is needed to explore and quantify the effects of continuous exposure to priming stimuli, and to understand the wider role of priming in a real-world environment.

Finally, despite the noted limitations, the results highlight significant potential for utilising priming through product design to influence social and behavioural norms and address individual and collective concerns in behavioural design.

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## Appendix: Review

<i>Study and area</i>	<i>Stimuli used</i>	<i>Measurement method</i>	<i>Outcome</i>
<b>Sight</b>			
(Ferraro et al., 2009) Consumer, 3 studies	Supraliminal images	Choosing 1 of 4 logos	Participants with more interdependent self-construal more likely to choose brand; increased likelihood of selecting primed brand
(Kim, You, & Lee, 2005) Consumer, 1 study	Subliminal images	Likert evaluation of perceived product worth	Participants primed with price had a lower preference towards the product; participants primed with size had a higher preference towards the product
(Berger, Meredith, & Wheeler, 2008) Social, 1 study	Supraliminal images	Voting on whether to support/not support an education initiative	Participants primed with images of schools were more likely to support the initiative
(Kay et al., 2004) Social, 5 studies	Subliminal images	Dividing \$10 between themselves and a co-participant; Choosing between two moves A or B to be aligned with another persons' choice. Two A's: 20 points each, two B's: 10 each, one A and one B: A gets 5, B gets 25	Participants primed with business related images were more likely to act competitively and share less
	Supraliminal images & words	Word completion test using 24 word fragments; Likert evaluation of the interaction between two people	Participants primed with business related images competed more competition related words, and perceived the interaction to be less about cooperation
	Subliminal objects	Dividing \$10 between themselves and a co-participant	Participants primed with business related objects offered less money to the co-participant
(Abbate, Boca, Spadaro, & Romano, 2014) Social, 2 studies	Supraliminal images	Asked if they were able to help another student with their work (Yes/No). If Yes they were asked to email from their own account	Participants primed with a simulation of being in a group were more likely to help
(Cesario, Plaks, & Higgins, 2006) Social, 2 studies	Subliminal images	Time taken to walk between two points	Participants primed with elderly images were slower than those primed with youth images
	Subliminal images & words	Likert evaluation of self regulation and hostility towards a minority group (gay men)	Participants primed with images of gay men were had higher hostility ratings
(Abbate et al., 2013) Social, 2 studies	Supraliminal words	Asked if they would offer money to support a student association; Confronted with a situation in which they could chose to help a fellow student	Participants primed with pro-social stimuli were more likely to offer money (but not more money in total), and were more likely to help
(Nenkov & Scott, 2014) Consumer, 1 study	Subliminal objects	Take as much ice-cream as they wanted – ice-cream weight used as measure	Participants took and ate more ice-cream when using a 'whimsical cute' scoop
(Fitzsimons et al., 2008) Social, 2 studies	Subliminal images	Alternative uses test of creativity	Participants primed with the Apple logo generated more unusual uses
	Supraliminal images	Social desirability test of honesty with 33 true/false items	Participants primed with the Disney logo were more honest
(Harris, Bargh, & Brownell, 2009) Social, 2 studies	Supraliminal & subliminal video	Presented with a bowl of food during a video, the amount of food consumed used as measure	Participants primed with food commercials during the video ate more

	Supraliminal & subliminal video	Rating food on a number of dimensions, and then allowed to eat – the amount of food consumed used as measure	Participants primed with snack-food commercials during the video ate more
<b>Sight and hearing</b>			
(Tropeano, 2006) Social, 1 study	Supraliminal music video	Likert evaluation of aggression	Participants primed with violent music had a higher aggression score
<b>Hearing</b>			
(Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007) Social, 5 studies	Supraliminal words	Asked to donate pay from the experiment to a student emergency fund	Participants primed with social exclusion contributed less
	Supraliminal words	Asked to rate their mood after being accepted/rejected during group work; asked to volunteer for follow up experiments	Participants primed with social exclusion volunteered for fewer follow up experiments
	Supraliminal words	Asked to help pick up some pencils knocked onto the floor by the experimenter	Participants primed with social exclusion helped less
	Supraliminal words	Asked to play the prisoners dilemma	Participants primed with social exclusion made fewer cooperative moves
(Andersson, Kristensson, Wästlund, & Gustafsson, 2012) Consumer, 1 study	Subliminal music	Likert evaluation of approach or avoidance behaviour on scales of: enjoyment, time experience, contact, and purchase experience	Participants primed with music spent more time and money in a store
(Egermann, Kopiez, & Reuter, 2006) Consumer, 2 studies	Subliminal music & words	Mark a word from a list while listening to one piece of music with/without word message; choose one of four drinks after listening to another piece of music with/without word message	No significant effects were identified
<b>Smell</b>			
(Liljenquist, Zhong, & Galinsky, 2015) Social, 2 studies	Subliminal scent	Play a one-shot anonymous trust game involving two parties: a sender and a receiver. The sender is given money to either keep or invest. Any money sent is tripled. The receiver decides how to split the tripled money. Participants played the receiver	Participants primed with a 'clean' scented room returned more money
	Subliminal scent	Asked to report their interest in volunteering for future Habitat for Humanity (charity organisation) efforts (Likert scale); specify the activities they would like to assist with, and indicate whether they wanted to donate funds to the cause (yes/no)	Participants primed with a 'clean' scented room were more interested in volunteering and had a higher willingness to donate money
(Holland, Hendriks, & Aarts, 2005) Social, 3 studies	Subliminal scent	Asked to indicate whether a letter string was an existing word (yes/no)	Participants primed with a 'clean' scented room responded faster to cleaning related words
	Subliminal scent	Asked to write down five activities that they were planning to do during the rest of the day	Participants primed with a 'clean' scented room more frequently listed cleaning activities
	Subliminal scent	Asked to eat a crumbly biscuit at a clean table. Video recording coded for	Participants primed with a 'clean' scented room removed crumbs more

(Li, Moallem, Paller, & Gottfried, 2007)	Subliminal scent	participants' cleaning behaviour Asked to smell different oils and then rate a number of faces' likability	often No significant effects were identified
Social, 1 study			
<b>Touch</b>			
(Krishna & Morrin, 2008)	Supraliminal object	Drink a cup of water through a straw with/without touching the cup, and then asked about the quality of the water	Participants primed with haptic input gave more negative evaluations
Consumer, 1 study			
(Guéguen, Jacob, & Boulbry, 2007)	Subliminal person	Observed for whether or not they tasted/not tasted the offered sample, bought/not bought something from a shop	Participants primed with haptic input were more likely to taste the sample, and more likely to buy something
Consumer, 1 study			

## **Appendix: Protocol**

### **Study 1**

#### ***Visual task brief:***

"Imagine that you are designers that have been headhunted to design the brand logo for a company. They are after a logo that communicates the company slogan 'Be Sustainable' visually. The name of the company and what the company does is not important, but it is very important that the logo visualises the slogan, without the use of words, letters or numbers. The company wants you to communicate the slogan only with the use of geometric and organic shapes. At this stage the company are interested in quantity over quality of suggestions. Therefore, produce as many suggestions as you can within the time limit.

There is no upper limit to how many suggestions that can be delivered."

#### ***Procedure:***

10 minutes to draw logos

With 30 seconds left: "You have 30 seconds left"

End: "Time is up"

#### ***Non-Visual task brief:***

"Imagine that you are designers that have been headhunted to design the brand for a company. They are after ideas (in words) that communicate the company slogan 'Be Sustainable' through sound, scent, and texture. The name of the company and what the company does is not important, but it is very important that the ideas represent the slogan. At this stage the company are interested in quantity over quality of suggestions. Therefore, produce as many suggestions as you can within the time limit.

There is no upper limit to how many suggestions that can be delivered."

#### ***Procedure:***

3 minutes to list words associated with SOUND

With 30 seconds left: "You have 30 seconds left"

End: "Time is up. Please turn the page to the next feature type"

3 minutes to list words associated with SCENT

With 30 seconds left: "You have 30 seconds left"

End: "Time is up. Please turn the page to the next feature type"

3 minutes to list words associated with TEXTURE

With 30 seconds left: "You have 30 seconds left"

End: "Time is up"

#### ***Common personal data:***

Age, gender, nationality, field of study, year of study

## **Study 2**

### **Common introduction:**

"You are about to participate in two separate tests. In the first we are looking at students and their cognitive skills. More specifically we want to see how you describe different stimuli. The second test is a common opinion survey conducted to see how students relate to a number of statements from everyday life. You will receive more specific instructions at the beginning of each test."

"In both tests the answers are personal and anonymous. It is important that the answers are honest and serious. In the end there will be a short debrief and a soda as a thank you for your participation."

### **Visual cues:**

"In this first task we will show you three different product renderings. Your task will be to look closely at these products and come up with three adjectives for each product that in your opinion is best used to describe its shape and dimensions. You can take as much time for each product as you need. After writing three adjectives for the first product proceed to the next. Do you understand the task?"

### **Non-visual cues:**

"In a moment you will be asked to put on this pair of headphones and a piece of fabric to cover your eyes. I will then present you with three sounds/smells/textures. For each you are going to tell me the three adjectives that in your opinion are best used to describe the stimuli. As soon as you think of the adjective you can just say it out loud. Once you have said three adjectives for the first stimuli we will product proceed to the next. Do you understand the task?"

### **Common sentence completion test:**

"In the following task you will be given a questionnaire with 15 random statements from everyday life. We want you to finish all these sentences as quickly as possible with the first word that comes to your mind after reading the sentence. It is important that you don't think too much about the sentence, and put down the very first word that you think of. Do you understand the task?"

1. A thing I would like to be doing more is ...
2. One of my biggest concerns is ...
3. I would like to eat more ...
4. I try to save money by ...
5. I hate it when people waste ...
6. Public transportation is ...
7. I think higher education is ...
8. I would like to limit my consumption of ...
9. A personal advice for a good life is ...
10. Before I die I want to ...
11. I would like to own ...
12. I think people should be more ...
13. When shopping for groceries, I look for ...
14. I think it is ignorant to ...
15. I believe it is important to ...

### **Common personal data:**

Age, gender, nationality, field of study, year of study

### **Common debrief:**

"The debrief lists a couple of control questions that helps us to secure the validity of your answers in the study."

1. When doing the study, did the two tasks seem to be related in any way? (If "yes") In what way were they related?
2. When doing the study, did anything you did in the first task affect what you did in the other? (If "yes") How did it affect you?
3. When doing survey, did you notice anything unusual about the sentences?
4. Did you notice any particular pattern or theme to the sentences when doing the second task?
5. Did you have any particular strategy when describing the sounds/smells/textures in the first task?